CPP 41: Focus Session: Wetting on Adaptive Substrates II (joint session CPP/DY/O)

The focus session aims to discuss recent developments in the wetting dynamics of adaptive, deformable, and switchable surfaces.

Time: Thursday 11:30–13:00 Location: H 0107

Invited Talk CPP 41.1 Thu 11:30 H 0107

A multi-scale approach to characterize wetting within a porous medium — •Maja Rücker[1], Ryan T. Armstrong[2], Chenhao Sun[3], Peyman Mostaghimi[2], Steffen Berg[4,5], Paul Luckham[5], Apostolos Georgiadis[4,5], and James E. McClure[6] — [1]Eindhoven University of Technology, Eindhoven, NL — [2]University of New South Wales, Sydney, Australia — [3]China University of Petroleum, Beijing, China — [4]Shell Global Solutions International B.V., Amsterdam, NL — [5]Imperial College London, London, UK — [6]Virginia Tech, Arlington, VA, USA

Considering a porous medium with two fluids in it, the fluid flow and distribution will depend on the wetting characteristic of the system. Recent developments in imaging techniques, such as micro-computed tomography and atomic force microscopy, alongside advances in computational modelling allowed for new concepts linking macroscopic wetting responses to the fundamental microscopic wetting definitions to emerge. We present an approach to upscale wetting parameters building upon energetic and geometric considerations and accounting for the various mechanisms related to wetting, manifesting at those different length scales. Starting from fluid-solid interactions, through the motion of three-phase contact lines to the evolution of fluid configurations in the porous medium, we show experimental observation on a coherent set of fluid/fluid/solid systems and discuss those in relation to the proposed upscaling concept. We will highlight the remaining questions for the characterization of wetting in the context of multiphase flow in porous media and point out future research directions.

CPP 41.2 Thu 12:00 H 0107

Soft Wetting Transition — •Christopher Henkel[1], Vincent Bertin[2], Jacco H. Snoeijer[2], and Uwe Thiele[1,3] — [1]Institut für Theoretische Physik, Universität Münster, Germany — [2]Physics of Fluids Group, Faculty of Science and Technology, Mesa+ Institute, University of Twente, The Netherlands — [3]Center for Nonlinear Science (CeNoS), Universität Münster, Germany

We investigate the forced receding dynamics of a three-phase contact line on a viscoelastic substrate. Thereby, we use the Landau-Levich (or dip-coating) geometry, where a solid viscoelastic plate is dragged out of a liquid bath. We employ a mesoscopic hydrodynamic model in long-wave approximation, i.e. valid at small contact angle and plate inclination. The elastic response of the substrate follows the Winkler foundation with a Kelvin-Voigt relaxation. In particular, we investigate how the shape and stability of the meniscus change with the plate velocity and the viscoelastic substrate properties. Finally we compare numeric results with asymptotic analytic calculations.

CPP 41.3 Thu 12:15 H 0107

Demixing around liquid droplets — •Khalil Remini and Ralf Seemann — Experimental Physics, Saarland University, Saarbrücken, Germany

Equilibrium polystyrene droplets are explored sitting on soft solid substrates. The soft solid substrates consist of commercial polydimethylsiloxane (PDMS) elastomer kits with elastic module varying across several orders of magnitude (3-1200 kPa). Inspecting the there-phase contact line of the droplets on a nanoscopic length scale by atomic force microscopy, i.e. on a length scale well below the elasto-capillary length, where capillary forces are higher than the elastic force of the substrate, we find that the ridge formed by the elastic substrate around the droplet is similar to that of a liquid. Material contrasts confirm a liquid ring surrounding the droplets at the three-phase contact line, as a result from stress induced demixing of non-crosslinked PDMS molecules from the PDMS elastomer matrix. This liquid ring extends for softer PDMS elastomers having a larger content of non-crosslinked molecules, but it is present also for the stiffer elastomers. So, the Neumann construction at the three-phase contact line is valid for all tested PDMS elastomers when measuring locally with sufficient resolution.

CPP 41.4 Thu 12:30 H 0107

Chemical reactions confined in liquid films: dynamics and stability — •Tilman Richter[1], Paolo Malgaretti[1], Thomas M. Koller[2], and Jens Harting[1] — [1]Forschungszentrum Jülich GmbH, Helmholtz-Institut Erlangen-Nürnberg für Erneuerbare Energien (IEK-11), Cauerstr. 1, 91058 Erlangen, Germany — [2]Institute of Advanced Optical Technologies - Thermophysical Properties (AOT-TP), Department of Chemical and Biological Engineering (CBI) and Erlangen Graduate School in Advanced Optical Technologies (SAOT), Friedrich-Alexander-Universit Erlangen-Nuernberg (FAU), Paul-Gordan-Straße 8, 91052 Erlangen, Germany

In catalytic reactions occurring within small liquid droplets or thin liquid films, the yield significantly differs from that in bulk reactions. This variance is primarily due to the fluid interface's substantial surface-to-volume ratio. The fluid interface initiates several phenomena, such as increased surface diffusion, Marangoni flows, and more effective surface interactions, which can boost yield substantially. We develop a theoretical model that demonstrates that the uneven distribution of reactants and products, caused by chemical reactions, can induce Marangoni flows. These flows then alter the spatial distribution of the catalyst. This complex interaction offers novel methods for either inhibiting or promoting the rupture of thin films, as well as for modifying the shape of small droplets.

CPP 41.5 Thu 12:45 H 0107

Dynamic vesicles on adaptive surfaces — •Lucia Wesenberg, Ben Rasmus Sprötge, Kai-Uwe Hollborn, and Marcus Müller — Institut für theoretische Physik, Georg-August-Universität Göttingen

Vesicles on substrates play a fundamental role in numerous biological transport processes, such as the neurotransmitter release at the synapse, transport vesicles in cells, or the nutrient intake of trees by large vesicles. For all of these processes the adaptive adhesion of the vesicles to a biological substrate is crucial. Furthermore, it is interesting to compare how these adaptive processes differ from wetting of liquid droplets as their shapes seem similar, however, one is governed by bending rigidity and the other by tension.

Here, we study the equilibrium shapes of vesicles as well as their dynamic adaptation to a changing substrate. Our simulations show the significant impact of buoyancy on the vesicle shape, especially in the contact zone. We are able to construct an adsorption diagram summarizing the metastable region of upward buoyant adsorbed vesicles. Further, we study permeable vesicles, adapting dynamically to substrates with a constant adhesion potential with periodically modulated strength or a steplike potential with a given velocity. A step in the potential allows the steering of vesicles, while periodic switching enables controlled vesicle substrate contact. Thus, both cases prove to be an effective control mechanism for biological transport of vesicles.